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An annotated list of the Butterflies of Delhi, India¹

BY

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(With two maps, a text-figure and three plates)

ABSTRACT

A collection of over 5600 butterflies from Delhi, India, obtained from 1961 to 1965, contained 72 species. An additional five species have been reported in the literature or are represented by specimens in the Indian Agricultural Research Institute, New Delhi.

For each species the following information is given : habitat preference, flying time (seasonal), total number of specimens, number of specimens of each sex, the sex ratio, maximum and minimum sizes observed in the material examined (given as the length of one forewing), variation, and the distribution of the species in India.

Two diverse habitats were heavily collected : the xerophytic Reserved Forest on the Ridge, a low prolongation of the Aravalli Hills ; and the mesophytic Sundar Nagar Nursery. The Nursery, and other parts of the cities of Delhi and New Delhi, have been so heavily irrigated that they differ radically from arid native habitats, such as the Ridge.

The development of the mesophytic urban habitat perhaps accounts for the presence of 14 species found in mesic areas east of Delhi, but not found in the arid land west of Delhi. Conversely, three species of *Colotis* plus the hesperiid *Pelopidas thrax thrax*, which are characteristic of arid land west of Delhi, occur on the Ridge but do not occur

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east of Delhi. Finally, *Pieris canidia indica*, *Colias electo fieldi*, and possibly *Argynnis hyperbius*, appear to be visitors from the Himalaya.

The greatest numbers and variety of butterflies are found during the monsoon season, from July through September, and afterwards through early November. The wet season form, in those species which have seasonal forms, usually occurs during the monsoon. But in at least six species (*Anapheis aurota*, *Cepora nerissa*, *Eurema hecabe*, *Colotis etrida*, *Ypthima inica*, *Precis almana*, and possibly *Precis orithya*) the colour pattern characteristic of the wet season appears as early as mid-April or May, two of the warmest, driest months of the year. This indicates that environmental factors other than humidity may be influencing the seasonal forms of these species.

The two female colour forms of *Colotis fausta faustina* are seasonal : the white form occurs during the monsoon ; the salmon-coloured form occurs at other times of the year.

Gongylus gongylodes (Orthoptera : Mantidae) is reported as a predator of *Colotis fausta*, and *Telenomus (Aholcus) talaus* (Hymenoptera : Scelionidae) is recorded as an egg-parasite of *Papilio demoleus demoleus* or *P. polytes romulus*.

The 'cyrus' female form of *Papilio polytes*, usually considered rare, is relatively common in Delhi.

The subspecies *minuta* Evans, originally ascribed to *Euchrysops pandava*, is merely the dry season form of *E. parrhasius parrhasius*, and is therefore a new synonym.

A list of 32 species which may occur in Delhi is included.

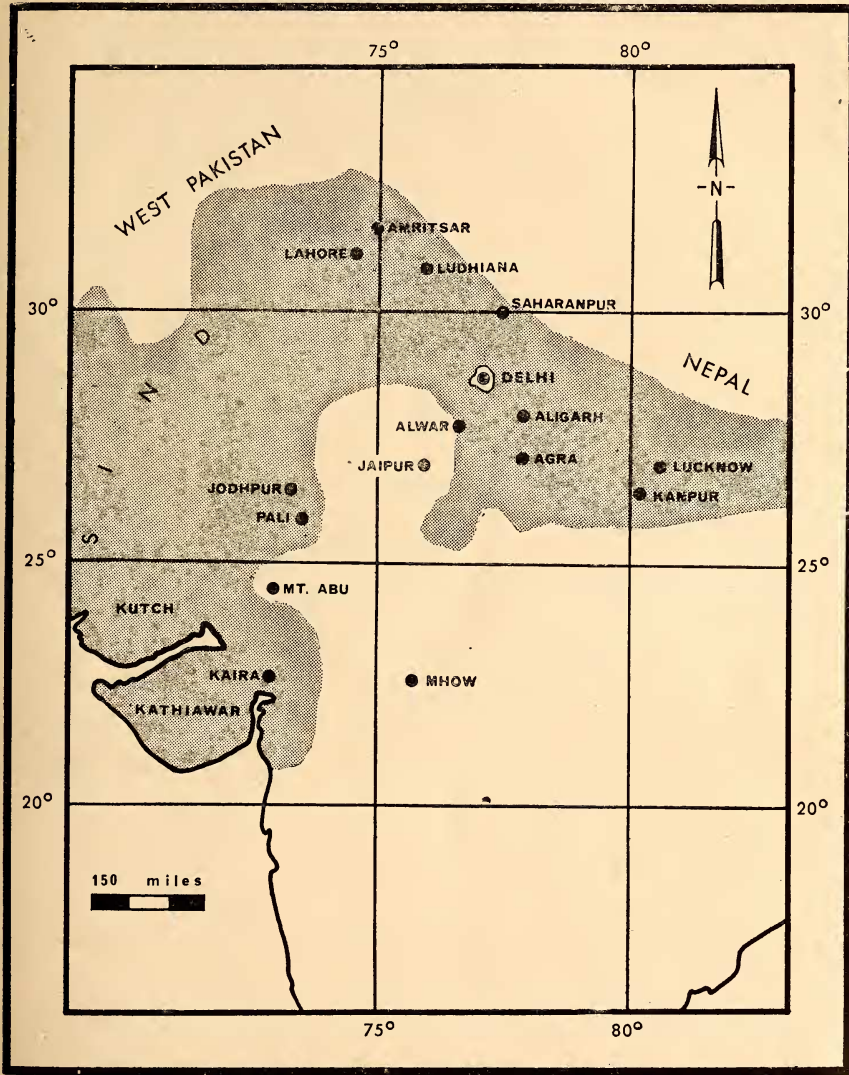
It is indeed surprising that no one has published a list of the butterflies of India's capital city, but the hot, arid climate of the north Indian plains has never been famous for inspiring the pursuit of Lepidoptera. Consequently, the only list of Delhi butterflies is a partial list of 21 species that Longstaff (1912) collected there in November 1903. Otherwise, no complete list is available for any locality nearer to Delhi than 250 miles.

DESCRIPTION OF THE STUDY AREA

Delhi is a Chief Commissioner's State of 574 square miles, wedged between the States of Punjab and Uttar Pradesh, on the Indo-Gangetic Plain at lat. 28° 40' N., long. 77° 10' E. (Maps 1 & 2).

Although it was not possible to survey the entire State, large collections were made in two diverse habitats: the Sundar Nagar Nursery (Map 2, Plate I, figs. 1 & 2), a lush area between the Zoological Park and Humayun's Tomb, on the south-east side of the State; and the 'Ridge' (Map 2, and Plate II, figs. 3 & 4, Plate III, figs. 5 & 6), a low (200-300 feet) prolongation of the Aravalli Hill Range that gradually disappears as it extends north-east to the Jumna River, which flows from north to south on the east side of Delhi. Unless otherwise stated, specimens collected on the Ridge were obtained in a Reserved

Forest west of the Ashoka Hotel, on either side of Link Road between Sardar Patel Road and Ridge Road (Map 2).

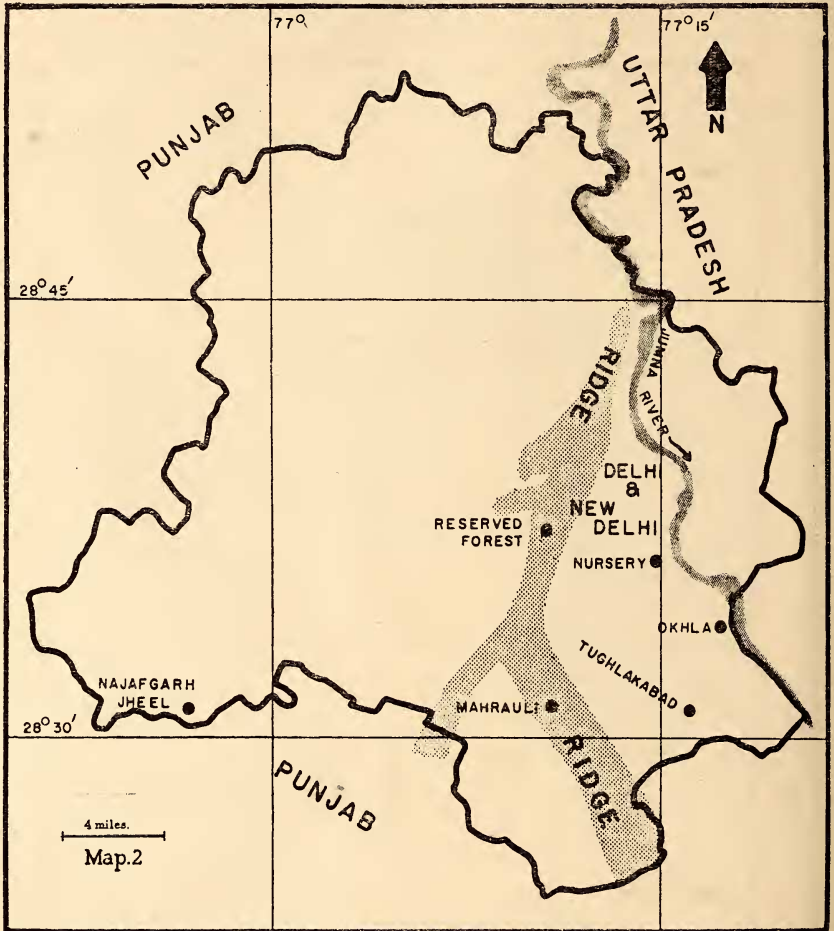


Map 1. Outline map of north-western India and West Pakistan, showing major collecting sites referred to in text. Approximate extent of Indo-Gangetic Plain is shaded.

The Nursery approaches a mesophytic habitat because of extensive irrigation throughout the year. Although flowers and shrubs are cultivated in much of the area, native grasses, shrubs, and trees occur in many parts of the Nursery (Plate I, figs. 1 and 2). Some Delhi butterflies, such as *Leptosia nina*, *Euploea core*, and, to a great extent, *Ypthima inica*, have been found only in restricted parts of this area.

SMITHSONIAN INSTITUTION

Mukherjee (1953) has classified the essentially native and little-disturbed vegetation of the Ridge (Plate II, figs. 3 & 4, and Plate III,



Map 2. Outline map of Delhi, India

figs. 5 & 6) into two categories: (1) the permanent vegetation, which occurs throughout the year; and (2) the ephemeral vegetation, which consists of annuals growing chiefly during the rainy season. He states: 'The permanent vegetation is xerophytic in ecological peculiarities due to the rigorous climatic and edaphic conditions and gives an appearance somewhat like a thorn scrub or bush jungle. But the number of plants is somewhat fewer than in other scrub jungles of India.' According to Mukherjee (1953), the most characteristic trees on the Ridge include *Azadirachta indica*, *Salvadora persica*, *S. oleoides*, *Prosopis spicigera*, *Acacia modesta*, *A. senegal*, *A. leucophloea*, *Cassia fistula*, *Ehretia laevis*, *Tecomella undulata*, *Balanites roxburghii*, and *Butea monosperma*. The

more numerous thorny shrubs on the Ridge include *Zizyphus nummularia*, *Grewia betulaefolia*, *Capparis aphylla*, *C. sepiaria*, *Celastrus senegalensis*, *Calotropis procera*, and *Carissa spinarum*. Mukherjee (1953) lists 178 species of plants, representing 44 families, that occur on the Ridge.

Reference should be made to Maheshwari (1963) for a complete analysis of the flora of Delhi.

In addition to the two major collecting sites above, small collections have been made in xerophytic situations at Tughlakabad Fort, eight miles SSE. of New Delhi, and at Okhla, the origin of the Agra Canal on the Jumna River, five miles south-east of New Delhi. A few specimens have also been collected near the Najafgarh Jheel, a large, shallow-water lake surrounded by open cultivated land 18 miles WSW. of New Delhi. With the few exceptions noted later, these localities have produced nothing unusual.

CLIMATE AND SEASONAL ABUNDANCE

The climate of Delhi can be characterized as semi-arid, but there are marked seasonal changes. It is cool and dry from October to February, hot and dry from March to early June, and hot and humid during the monsoon from mid-June through September. The precipitation and temperature data are given for each month in Table 1, along with the number of species that have been collected in each month.

TABLE 1

MONTHLY RAINFALL AND TEMPERATURES IN DELHI, INDIA (SOURCE : SOHONI 1953),
WITH THE NUMBER OF SPECIES OF BUTTERFLIES RECORDED FOR EACH MONTH

Month	Rainfall (inches)	Temperature (°F.)		No. Spp. Collected
		mean daily max.	mean daily min.	
January	0.99	70.5	43.3	26
February	0.83	74.7	49.2	32
March	0.51	85.0	57.1	38
April	0.33	96.6	67.7	31
May	0.52	104.8	78.8	26
June	3.03	102.4	82.5	13*
July	7.03	95.3	80.1	41
August	7.23	93.0	78.4	53
September	4.84	93.5	75.5	47
October	0.40	92.5	64.3	31*
November	0.10	83.2	51.8	55
December	0.43	73.7	45.0	38

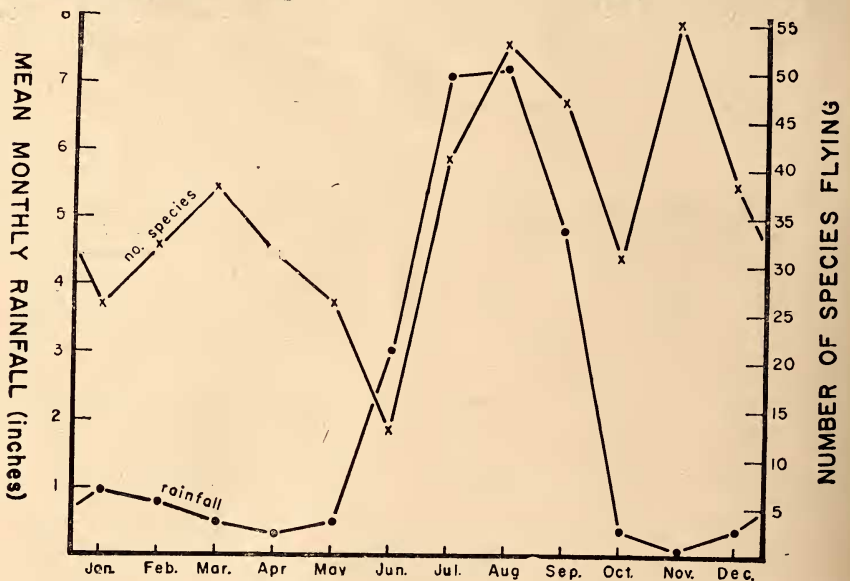
* June and October were relatively poorly collected. A fairly low number of species is expected in June, but over 50 species should be expected in October.

Of the mean annual rainfall of 26.24 inches, 84% occurs during the monsoon from June through September. The dry conditions prevailing

from October to May dictate the arid nature of the native vegetation. During the monsoon, however, the vegetation flourishes. Most plants produce lush new growth at a rapid pace, and almost overnight the land is green where leafless trees and hard bare ground had been but a few weeks earlier (see Plate II, figs. 3 & 4, and Plate III, figs. 5 & 6 for examples of the changes). The pronounced change in the vegetation during the monsoon has been studied in Gujarat by Saxton (1924).

The activity and abundance of the butterflies are strongly correlated with the climatic events in Delhi. Most species occur only during the monsoon, or are most common at that time (Table 1, and text-fig.). Butterfly numbers then decrease from mid-November to February, when specimens are scarce. Some species become extremely abundant during the hot season (*Anapheis aurota* and *Colotis fausta*, for example), but the variety of species on the wing gradually declines to a low point in June. About two weeks after the monsoon breaks (the onset is variable, but is usually in late June) the air is once again filled with butterflies.

The graph of monthly precipitation and the number of species occurring in a given month (text-fig.) demonstrates the time lag between a change in the pattern of rainfall and a change in the number



Text-figure. Number of species of butterflies recorded each month in Delhi, correlated with mean monthly rainfall.

of species flying. No attempt has been made to estimate relative numbers of butterflies during the different months, although the number of species collected was usually directly related to the number of individuals flying.

Donahue : Butterflies of Delhi



1. Uncultivated lowland area on north side of Nursery (Zoo in background). *Ypthima inica* most abundant in tall grass in centre of photograph. 1 July 1962.
2. Native grasses and thorn shrubs and trees in Nursery, looking south from the area in 1, towards Humayun's Tomb (right centre background). 1 July 1962.

(Photos : Julian P. Donahue)

Donahue : Butterflies of Delhi



3. Dry season aspect of vegetation in Reserved Forest on the Ridge. 9 May 1962. 4. Wet season aspect of same area as 3, on 14 Aug. 1962. Note change in the ground cover, in foliage of trees, and in vine in foreground.

(Photos : Julian P. Donahue)

SEASONAL VARIATION

Many species of Delhi butterflies have two well-marked seasonal forms, associated with the wet and dry seasons. Wet season specimens are usually larger and more conspicuously patterned than dry season specimens, while the seasonal forms of some species even have different wing shapes. *Eurema hecabe* is an exception, in that the dry season form is heavily marked on the underside, while the wet season form is almost immaculate on the underside.

Previous authors have implied that the wet season form occurs only during the monsoon, but this certainly is not true in Delhi. In at least six species (*Anapheis aurota*, *Cepora nerissa*, *Eurema hecabe*, *Colotis etrida*, *Ypthima inica*, *Precis almana*, and possibly *Precis orithya*), the colour pattern characteristic of the wet season appears in *all* specimens as early as mid-April or May—two of the hottest, driest months of the year—and lasts until sometime after the monsoon, depending on the species. These pre-wet-season forms may be smaller than wet season specimens, but in their facies (and wing shape, in *P. almana*) they are identical to wet season individuals.

The factors responsible for the appearance of the seasonal forms have been the subject of some experimentation and much speculation. Marshall (1901) and Dixey (1902) concluded, after a series of experiments, that the seasonal forms were influenced by both temperature and humidity. Apparently no modern, more sophisticated, research has been conducted into the problem, but Sevastopulo (1944) believes that three factors operate, either separately or in conjunction, to influence the form of a butterfly: (1) condition of the food; (2) effect of atmospheric humidity on the larva; and (3) effect of atmospheric humidity on the pupa. He further believes that the nature of the food or relative humidity alone are not the complete explanation of the phenomenon.

The appearance of the 'wet-season' form of some Delhi species in the dry season, mentioned earlier, indicates that some factor other than humidity may affect those species, although the majority of the Delhi wet-season specimens appear to be restricted to the monsoon season. It is quite possible that the factors affecting the form of a butterfly are different for different species.

METHODS OF COLLECTING

The butterfly collector in Delhi has poor success with special collecting methods—such as baits, models, or locating butterflies swarming on stream-banks—which are often successful in a moist forest habitat. Collecting butterflies at flowers, stalking them (especially *Precis*), or

chasing the fast-flying species are the only methods which have produced results in Delhi. Some species, such as *Leptosia nina* and *Mycalesis perseus*, must be beaten from the grass, while low-flying species (*Eurema*, *Zizeeria*, etc.) can be obtained by gentle sweeping. During warm weather it is advisable to do the bulk of the collecting before 10 a.m., while the butterflies are attracted to flowers and before they begin flying more rapidly. A warm day on the Ridge can be most exhausting, since the butterflies seldom pause in their headlong flight through the scrub, and many were the times when both collector and net became snagged and torn on the thorns.

No mass movements ('migrations') of butterflies have been observed in Delhi, although this phenomenon has been reported elsewhere in India for species which occur in Delhi. But some species, such as *Colias electo* and *Pieris canidia* probably emigrate to Delhi from the Himalaya, although so few specimens reach Delhi that it would be difficult to detect the movement.

METHOD OF STUDY

The list which follows is the result of the examination of 5611 mounted specimens, representing 72 species, collected by the author from May 1961 to August 1962, and by Roy L. Donahue and Reed C. Finrock from 1962 to 1965. A few additional specimens were purchased from Miss Nirmala of Delhi, who provided specimens collected by 'Venu', Leela R. Menon, and herself. All these specimens form a part of the collection of Indian butterflies deposited in the Entomology Museum at Michigan State University (MSU). Five additional species that were not examined have either been reported from Delhi in the literature or are represented by single specimens in the collection of the Indian Agricultural Research Institute (I.A.R.I.), New Delhi.

The total number of specimens examined is given for each species, followed by the number of specimens of each sex and the sex ratio (given as the percentage of males). With only a few exceptions (such as *Hypolimnas misippus*, *Ixias pyrene*, *Papilio polytes*, and *Colotis fausta*), males could not be distinguished from females in the field, so the sex ratio as given should reflect the relative abundance of the two sexes under field conditions at the time of collecting, although it is well known that behaviour and other ecological factors generally make the females of some species very difficult to find. The relationship between the sex ratio observed in the field and the actual sex ratio of a species can only be derived from rearing experiments and studies of predation, parasitism, and behaviour. The sex was determined by

examining the abdomen of all specimens, even of those species which are sexually dichromic.

To simplify the presentation of data on seasonal occurrence, each month has been divided into quarters, designated by Roman numerals as follows: I = 1-7; II = 8-14; III = 15-21; and IV = 22-end of the month. Because of the probability that a given species was not collected during every week it was flying, and because most Delhi butterflies appear to be continuously brooded in all except the winter months, the flying time is assumed to be continuous if the interval between collection records is four quarters or less. For example, if a given species was collected in the first and fourth weeks of October, and again in the third week of November, the flying time will be presented as October I to November III. June, October, and, to some extent, September have been poorly collected, and it is to be expected that additional records from these months may alter the known flying time of a species. The precise date of each capture is given if twelve or fewer specimens of a species have been collected.

The size of specimens, given in millimetres, is the length of one forewing from base to apex.

The species included in this paper were identified according to the following references: Evans (1949)—Hesperiidae; Talbot (1939)—Papilionidae, Pieridae; Cantlie (1962)—Lycaenidae; Evans (1932)—Nymphalidae; and Talbot (1947)—Danaidae, Satyridae. Monographs of certain groups have been referred to whenever possible. The names used in this paper follow the above authors, unless subsequent investigations have shown other names to be more appropriate. The arrangement of species follows the above authors, while the arrangement of families follows dos Passos (1964). The figures in Wynter-Blyth (1957), Seitz (1927), and in various volumes of LEPIDOPTERA INDICA (Moore, 1890-1900; Swinhoe, 1905-1913: volumes V and VI were not consulted) were occasionally consulted for the clarification of a description. Terminology of the genitalia follows Klots (1956).

'Form' names are avoided whenever possible, especially for seasonal forms, since these names have no taxonomic validity. Some species, however, have distinct forms which, for the sake of recognition, are occasionally referred to by name.

Frequent reference is made in this paper to lists of butterflies published for other localities in north-western India and West Pakistan. The nearest localities and their distances from Delhi are as follows (see Map 1): Lucknow, Uttar Pradesh, 250 miles SE. of Delhi (de Rhé-Philipe 1902, 1905); Kanpur, U.P., 240 miles SE. of Delhi (partial list, Sevastopulo 1948); Lahore, West Pakistan, 250 miles NW. of Delhi (de Rhé-Philipe 1917); Amritsar, Punjab, 250 miles NW. of Delhi (partial list, Sevastopulo 1948); Fatehgarh, Punjab, 140 miles

NNW. of Delhi (partial list, Peile 1911); Jodhpur, Rajasthan, 300 miles WSW. of Delhi (MacPherson 1927); and Lyallpur, West Pakistan, 300 miles NW. of Delhi (partial list, Sevastopulo 1948).

Other, more distant localities (Map 1) whose lists have been consulted include Sind (the southern portion of the Indus Valley), West Pakistan, about 400 miles west to about 600 miles WSW. of Delhi (Swinhoe 1887; Menesse 1950); Kutch (region), Gujarat, about 600 miles SW. of Delhi (Nurse 1899); Kathiawar (region), Gujarat, about 600 miles SW. of Delhi (Mosse 1929); Mount Abu, Rajasthan, 380 miles SW. of Delhi (MacPherson 1927); Kaira District, Gujarat (near Ahmedabad), 580 miles SSW. of Delhi (Aldrich 1946); and Mhow, Madhya Pradesh, 420 miles SSW. of Delhi (Swinhoe 1886).

The terms used in this paper for the relative abundance ('common', 'rare', etc.) are the terms used by the above authors to indicate the status of species in their respective areas.

To clarify the range of certain species, occasional reference is made to specimens in the Michigan State University collection from the following localities (Map 1): Saharanpur, Uttar Pradesh, 90 miles NNE. of Delhi; Aligarh, U. P., 70 miles SE. of Delhi; Agra, U. P., 110 miles SSE. of Delhi; Ludhiana, Punjab, 170 miles NNW. of Delhi; Siliserh, Rajasthan (5 miles south of Alwar), 90 miles SSW. of Delhi; Jaipur, Rajasthan, 140 miles SW. of Delhi; and Sumerpur, Rajasthan (45 miles SSW. of Pali), 340 miles SW. of Delhi.

The following abbreviations are used in the text :

Wing surfaces

UPF—	upperside (dorsal surface) of the forewing.
UPH—	do. do. hindwing.
UNF—	underside (ventral surface) of the forewing.
UNH—	do. do. hindwing.

Seasonal forms

WSF—	wet-season form
DSF—	dry-season form

Collectors

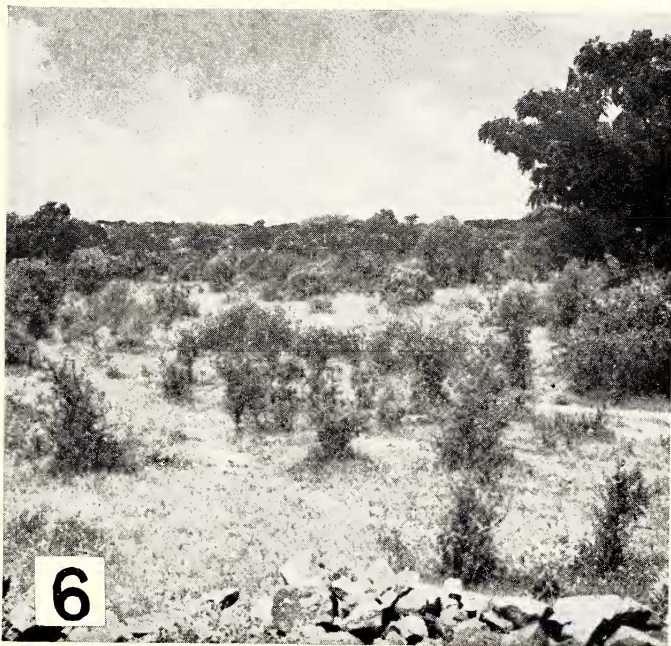
JPD—	Julian P. Donahue.
RLD—	Roy L. Donahue.
RCF—	Reed C. Finrock.

AFFINITIES OF THE DELHI BUTTERFLY FAUNA

The butterfly fauna of Delhi is poor compared to that of the montane, mesophytic habitats of the Western Ghats or the Himalaya. With the exception of *Colias electo*, *Pieris canidia*, and possibly *Argynnis hyperbius*, which are presumably immigrants from the Himalaya, all Delhi butterflies are characteristic of the populations of peninsular India, rather than of the adjacent Himalaya.

On the Indo-Gangetic Plain, a deep alluvial tertiary deposit between the Himalaya and peninsular India, the number of species decreases as

Donahue : Butterflies of Delhi



5. Dry season aspect of vegetation in another portion of Reserved Forest on the Ridge. 9 May 1962. 6. Wet season aspect of same area as 5, on 14 Aug. 1962. Note the marked increase in grasses. Large tree on right is *Azadirachta indica*.

(Photos : Julian P. Donahue)

one goes west. The annual precipitation also decreases as one goes west to the Great Indian Desert where, in some years, there is no precipitation at all. Conversely, the hill ranges of India generally receive a great amount of precipitation and have a rich butterfly fauna.

The 77 species of Delhi butterflies represent seven families (Table 2). For comparison with other localities on the Indo-Gangetic Plain, 84 species have been recorded south-east of Delhi in Lucknow District, U.P. (de Rhé-Philipe 1902, 1905); 54 species north-west of Delhi in Lahore, West Pakistan (de Rhé-Philipe 1917); and 51 species WSW. of Delhi in Jodhpur, Rajasthan (MacPherson 1927).

TABLE 2

FAMILY REPRESENTATION IN DELHI

<u>FAMILY</u>	<u>NUMBER OF SPECIES</u>
Hesperiidae	.. 11
Papilionidae	.. 4
Pieridae	.. 20
Lycaenidae	.. 22
Nymphalidae	.. 13
Danaidae	.. 4
Satyridae	.. 3
Total	.. <u>77</u>

Extensive irrigation and the introduction of a multitude of exotic trees and shrubs have apparently altered the environment of the cities of Delhi and New Delhi to the point where the shaded residential areas have a lower temperature and a higher humidity. The cities are verdant oases set in a parched land, and several species of butterflies are virtually restricted to the irrigated city. Were it not for the creation of this mesophytic habitat, there is little doubt that fewer species would occur in Delhi.

The diversity of the two major habitats in Delhi perhaps explains the occurrence in Delhi of 20 species of butterflies which appear to be on the periphery of their known ranges (Table 3). The majority of these are more or less restricted to the mesophytic city habitat and have not been reported west of Delhi, where the climate becomes even more arid. Some of these species may occur in the Great Indian Desert, but collections have apparently not been made there.

Four of the remaining peripheral species are characteristic of the arid land west and south-west of Delhi, but have not been recorded east of Delhi, while two species appear to be stragglers or strays from the Himalaya.

In the Delhi area, as is true wherever man goes, the native vegetation must have been considerably altered when land was cleared, crops

were planted, and livestock were turned loose to overgraze the land (see Donahue 1962c). The vegetation on the Ridge probably represents only a portion of once-extensive thorn forests.

Beirne (1947a, 1947b) has noted that, at least in the British Isles, the net result of the activity of man and his animals is the decline or disappearance of populations of many species of Lepidoptera, while relatively few species become more numerous. Apparently no studies of the population ecology of Indian butterflies have been undertaken, but this list of species could well form the foundation for such an investigation in Delhi itself.

TABLE 3
DELHI BUTTERFLIES THAT APPEAR TO BE ON THE PERIPHERY OF THEIR
KNOWN RANGES

<u>Species</u>	<u>Periphery</u>
<i>Spialia galba galba</i>	.. western
<i>Suastus gremius</i>	.. do.
<i>Parnara naso bada</i>	.. do.
<i>Borbo cinnara</i>	.. do.
<i>Graphium nomius nomius</i>	.. do.
<i>Leptosia nina nina</i>	.. do.
<i>Delias eucharis</i>	.. do.
<i>Ixias marianne marianne</i>	.. do.
<i>Ixias pyrene sesia</i>	.. do.
<i>Rapala iarbus ssp.</i>	.. do.
<i>Charaxes fabius fabius</i>	.. do.
<i>Euthalia nais</i>	.. do.
<i>Mycallexis perseus tabitha</i>	.. do.
<i>Ypthima inica</i>	.. do.
<i>Pieris canidia indica</i>	.. south-western
<i>Colias electo fieldi</i>	.. do.
<i>Pelopidas thrax thrax</i>	.. eastern
<i>Colotis calais amata</i>	.. north-eastern
<i>Colotis vestalis vestalis</i>	.. do.
<i>Colotis fausta faustina</i>	.. do.

ACKNOWLEDGEMENTS

Were it not for the munificence of The Ford Foundation, which financed the transportation of the author and his gear to India, this study would not have been possible. My primary debt of gratitude is therefore tendered to this great organization.

To my father Dr. Roy L. Donahue and to my good friend Reed C. Finrock I am deeply indebted for the several thousand specimens of butterflies they collected in Delhi after my departure. My strict instructions to collect every lycaenid and hesperiid they encountered, to the

neglect of larger species, bore fruit: not only was I swamped with tremendous series of common species, but they found several species which I myself had failed to collect in Delhi. To Mrs. Evelyn Jackson, who had the hideous task of mounting all that exiguous material, I am grateful for a job well done.

I further wish to thank Mr. T. G. Howarth and Mr. G. E. Tite, of the British Museum (Natural History), for assistance with taxonomic problems and for examining some Delhi specimens in their care; and Dr. M. G. Ramdas Menon of the Indian Agricultural Institute, New Delhi, for allowing me to examine some of his Delhi butterflies in that institution's collection.

Sir Keith Cantlie was most generous in allowing me to borrow his copy of the rare first edition of THE IDENTIFICATION OF INDIAN BUTTERFLIES by W. H. Evans, without which it would have been more difficult to properly assign names to the nymphalids.

To Dr. Irving J. Cantrall, of the University of Michigan, and C.F.W. Muesebeck, of the U.S. National Museum, go my thanks for identifying a mantid predator and hymenopterous parasites, respectively, of Delhi butterflies.

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ACCOUNT OF SPECIES

HESPERIIDAE

Several of the 11 known species of skippers from Delhi are very similar in appearance. Although there are many characters to separate the groups, such as tibial spines, genitalia, and antennae, only the salient features of the facies of each species are listed here. Complete keys and figures of male genitalia will be found in Evans (1949).

Gangara thyrsis, *Hasora chromus*, and *Badamia exclamationis* are large species, all of which are figured by Wynter-Blyth (1957). *Spialia galba*, a small species with many white spots, is also figured by Wynter-Blyth. *Telicota colon* is the only orange skipper so far recorded from Delhi (figured in Wynter-Blyth as *Astychus augias*). *Gegenes nostrodamus* is a very pale brown species, whose male has no spots on the upperside, while *Suastus gremius* is the only Delhi species with black spots UNH. Both these latter species are also figured by Wynter-Blyth.

The remaining four species have spotted UPF and are very similar in appearance. *Parnara naso* has no spot in space 1b UPF and no male stigma; *Borbo cinnara* has no spot in the cell UNH, has no male stigma

UPF, and usually does not have two spots in the cell UPF. The two species of *Pelopidas* which can be identified only after genitalic examination, have male stigmas, two spots in the cell UPF, and one spot in the cell UNH. The combinations of these characters will separate the species that have been recorded from Delhi, but additional skippers undoubtedly occur and should be looked for.

Because of recent taxonomic changes and the recognition of new species in this family, published records of the distribution of some species cannot be considered totally reliable.

***Hasora chromus chromus* (Cramer)**

The Common Banded Awl is, as the name implies, the most common and widespread *Hasora* in India, although only five specimens have been collected in Delhi. I collected two males on *Lantana* flowers in the Nursery (26 Aug. and 21 Sept. 1961), while Leela R. Menon collected two males and a female in Delhi (Oct. 1962). These last records indicate that the species may be locally common in suitable habitats. A large skipper, probably this species, was observed on *Lantana* in the Nursery, 4 Nov. 1961, but was not collected.

SIZE: The specimens range in size from 17 mm. to 22 mm.

DISTRIBUTION: This subspecies occurs throughout India (Evans 1949; Wynter-Blyth 1957), and has been recorded as far west as Karachi (Menesse 1950), where it is very rare.

***Badamia exclamationis* (Fabricius)**

Only two males have been examined, both of which were collected by JPD in the Nursery. The first (23 mm.) was taken on 20 July 1962 as it fed on a white-flowered *Lantana* at midday. A second specimen (26 mm.) was collected the following day on *Lantana*, and another was seen but not secured. A few days later RCF obtained three specimens, which remain in his personal collection.

DISTRIBUTION: The Brown Awl occurs rather locally throughout India (Wynter-Blyth 1957), but the British Museum (N.H.) has no specimens west of 'North India' (Evans 1949). It has been recorded from Lucknow (de Rhé-Philipe 1902), where the eggs and larvae were found on *Bignonia gracilis* (de Rhé-Philipe 1905). It has also been recorded from Mount Abu, but not in Jodhpur, by MacPherson (1927); Kutch (Nurse 1899); and Kathiawar (Mosse 1929). It is very rare in Karachi (Swinhoe 1887; Menesse 1950), which is apparently the westernmost record for the species.

***Spatialia galba galba* (Fabricius)**

The Indian Skipper, a small but distinctive species, has been collected only sporadically in Delhi. In the Nursery, a female was taken on 15 July 1961 (JPD), and another was collected on 18 November 1962 (RLD). On the Ridge, a male was obtained on 26 Feb. 1963 (RCF), while a female was collected on 9 August 1962 (JPD). In addition, two males and a female were collected in Delhi by Venu, Dec. 1962.

SIZE: Males and females range from 8 mm. to 11 mm.

DISTRIBUTION: This subspecies occurs throughout India, west to Kutch and Sind, east to Assam (Evans 1949). It has not been reported from Jodhpur (MacPherson 1927), is apparently rare in Lahore (de Rhé-Philipe 1917), but is fairly common to common in Lucknow (de Rhé-Philipe 1902), Kutch (Nurse 1899), Kathiawar (Mosse 1929), and Sind (Swinhoe 1887; Menesse 1950). This species may be near the western limits of its range at the latitude of Delhi.

***Suastrus gremius gremius* (Fabricius)**

Only five males of the Indian Palm Bob have been collected in Delhi. Two came from the Nursery (25 Sept. 1961, JPD; 17 Nov. 1962, RCF), while Leela R. Menon collected three in Delhi in Nov. 1962. These last records would imply that this species may be more common on the north side of Delhi where the food plants, various species of palm, are more common.

SIZE: The forewings are from 11 mm. to 12 mm. long.

DISTRIBUTION: This distinctive subspecies occurs in south and central India, the north-west Himalaya, and Bengal, Sikkim, and Assam (Evans 1949; Wynter-Blyth 1957). It is the most common hesperiid in Lucknow (de Rhé-Philipe 1902), though it is uncommon in Lahore (de Rhé-Philipe 1917), rare in Kutch (Nurse 1899) and Kathiawar (Mosse 1929), very rare in Karachi (Menesse 1950), and apparently absent from Jodhpur (MacPherson 1927). This species appears to be near the western limit of its range at the latitude of Delhi.

***Gangara thyrasis thyrasis* (Fabricius)**

The only Delhi record of this species is a single specimen in the British Museum (N.H.) from the Godman-Salvin collection [B.M. No. 1913-2] (T.G. Howarth, pers. comm.: specimen cited in Evans 1949, p. 325).

This subspecies of the Giant Redeye occurs from south India to Bombay and Calcutta, and again from Kangra (Punjab Himalaya) to Sikkim, Assam, and farther east. The specimen from Delhi, assuming

no labelling error, is apparently the only record from the Indo-Gangetic Plain, and should be substantiated with additional material. This huge skipper is crepuscular, and should be looked for near various species of palms, the food plant. Beating the bushes during the day-time may dislodge a resting specimen.

***Telicota colon colon* (Fabricius)**

The Pale Palm Dart, the only orange skipper so far recorded from Delhi, has been collected from Sept. IV to Nov. IV, a period during which most of the Delhi hesperiids make their appearance. This species reportedly feeds on sugarcane, so it may be locally common in the parts of Delhi where this crop is grown. Miss Nirmala collected three males in Delhi in Nov. 1962, but all the rest of the specimens examined were taken in the Nursery : one male on 25 Sept. 1961 (JPD), one male on 3 Nov. 1962 (RCF), two males on 4 Nov. 1961 (JPD), a male and a female on 17 Nov. 1962 (RCF), and one male on 25 Nov. 1962 (RCF).

The only hesperiid collected in Delhi by Longstaff (1912), 7-12 Nov. 1903, was probably this species.

SIZE : The specimens range in size from 14 mm. to 16 mm.

DISTRIBUTION : Evans (1949) records specimens in the British Museum (N.H.) from south and central India, Kathiawar, Kumaon, and from the U.P. to Sikkim. Two other subspecies occur in Ceylon, the Andaman Islands, and Assam.

Distributional lists published prior to the appearance of Evans's CATALOGUE (1949) are unreliable, since there appears to have been a considerable amount of confusion and misapplication of names in the two similar genera of *Potanthus* and *Telicota*. Specimens on which earlier lists were based should be re-examined in the light of the recent taxonomic changes before they can be included in our present knowledge of the distribution of the species. An examination of the genitalia, which are figured in Evans (1949), is virtually essential for the proper identification of most species.

This species is described and figured as *Astychus augias* (Linnaeus) in Wynter-Blyth (1957), who omits reference to two other species of Indian *Telicota*.

***Gegenes nostradamus* (Fabricius)**

Only nine males of this arid-land skipper have been collected in Delhi, all from the Nursery : 26 June 1961, 20 July 1962 (3 specimens), 21 and 31 July 1962 (JPD); 3 and 9 Sept. 1962 (RLD); and 4 Nov. 1962 (RCF). Darker specimens occur from late July (when light speci-

mens also occur) to November. The genitalia of all specimens were examined, but *G. pumilio* (Hoffmansegg) was not found, although it has been recorded as far east as the Punjab and Kulu (Evans 1949). This latter species was omitted by Wynter-Blyth (1957).

SIZE: The specimens range from 13 mm. to 14 mm.

DISTRIBUTION The Dingy Swift has been recorded east to Sind; Kutch; Deesa, Gujarat; NW. Frontier Province; and the Punjab, then becomes rare through the U.P. to Bengal (Evans 1949). Longstaff (1912) took it in Lahore, although de Rhé-Philipe (1917) failed to find it there; Aldrich (1946) records it from Kaira District; Menesse (1950) and Swinhoe (1887) have collected it in Sind; and Nurse (1899) took it in Kutch. There are two additional specimens in the Michigan State University collection from Ludhiana, Punjab (12 Sept. 1961).

Parnara naso bada (Moore)

This is the only white-spotted brown skipper so far recorded from Delhi which does not have a spot in space 1b UPF or UNF. Only six specimens have been collected in Delhi, all of which came from the Nursery, Aug. IV to Nov. IV: one male on 26 Aug. 1961 (JPD); one female on 21 Sept. 1961 (JPD); one female on 4 Nov. 1961 (JPD); a male and a female on 4 Nov. 1962 (RCF), and a male on 22 Nov. 1962 (RCF).

SIZE: The forewing is from 14 mm. to 15 mm. long.

DISTRIBUTION: This butterfly occurs in India from Ceylon north to Kashmir and east to Sikkim and Assam (Evans 1949). Wynter-Blyth (1957) apparently included this species with *P. guttatus mangala* (Moore), which is only known to occur in the Himalaya from Chitral to Sikkim and Assam (Evans 1949). *Parnara naso bada* has been recorded from Mount Abu (MacPherson 1927), but other authors have failed to report its occurrence in localities nearer Delhi. There is an additional specimen in the MSU collection from Aligarh, U.P., 17 Nov. 1962 (RLD). Delhi appears to be the westernmost locality recorded for this species at this latitude.

Borbo cinnara (Wallace)

This species is similar to *Pelopidas* females, but can be separated with the characters listed in the introduction to the family. It has been collected only in the Nursery from July III to Nov. IV. 41 specimens: 20 males (49%), 21 females.

SIZE: The forewing length of males and females varies from 14 mm. to 17 mm.

VARIATION: In one female (28 Aug. 1961, JPD) the subapical spots

UPF are almost indiscernible, and the spot in space 1b UPF is absent. The other spots UPF are smaller than usual.

DISTRIBUTION: Although the British Museum (N.H.) has many specimens from India, there appear to be none from west of 'Central India' (Evans 1949). *B. cinnara* has also been recorded from Mount Abu (MacPherson 1927) and Kathiawar (Mosse 1929) as *Baoris colaca* (Moore), a synonym. Previous authors may have confused this species with *Borbo bevani* (Moore) which, though not yet collected in Delhi, has been reported from Lahore (de Rhè-Philipe 1917) and Karachi (Swinhoe 1887). All these records should be re-examined in the light of the revisional work by Evans (1949).

***Pelopidas thrax thrax* (Hübner)**

This species is very similar to *P. mathias*, but it is less common. The males can be distinguished by the position of the stigma UPF: in *P. thrax* the posterior end of the stigma is under the origin of Cu_1 , while in *P. mathias* the posterior end of the stigma is well proximal to the origin of Cu_1 . The male and female genitalia of all Delhi *Pelopidas* have been examined.

The females of these two species are very similar, and only an examination of the genitalia can separate them.

Among the Delhi *Pelopidas*, two types of female genitalia were found: (a) the less common type of female has a lateral, linear, well-defined sclerotized signum on both the right and left sides of the bursa copulatrix; (b) the more common type of female has only a diffuse, indistinct signum on the left side of the bursa copulatrix.

Since no copulating pairs of *Pelopidas* have come into my possession, there is still some doubt as to which type of female to associate with which species. I have arbitrarily assumed that the more common female, type (b), is associated with the more common male, *P. mathias*. Conversely, the type (a) female has been associated with *P. thrax*.

Pelopidas thrax is usually encountered in the Nursery, where it flies with *P. mathias*, but five specimens have been collected on the Ridge. It is probably more frequent on the Ridge than the records indicate, but the dearth of attractive flowers makes this fast-flying species difficult to collect. It has been collected in February IV and March II (Ridge), from July II to November IV (Nursery), and in December IV (Ridge). 35 specimens: 23 males (66%), 12 females.

SIZE: Males and females range from 15 mm. to 17 mm.

DISTRIBUTION: The only Indian record of this western subspecies in the British Museum (N.H.) is a single male from Kutch (Evans 1949), although Evans (1949) and Menesse (1950) report that this species is

common in Sind. Evans (1949) also records two males of a second subspecies, *P. t. masta* Evans from Sikkim. There appear to be no other published records of this species from India, but earlier authors may have confused it with other species. Wynter-Blyth (1957) has omitted it from his book, on which many collectors rely. The author has also collected two males 15 miles south of Saharanpur, U.P., 8 May 1961.

***Pelopidas mathias mathias* (Fabricius)**

The most common Delhi skipper, numerous on *Lantana* during and after the monsoon. It has been collected in most habitats, March I and IV, and from July III to December I, although it is most frequently collected in the Nursery. 100 specimens : 69 males (69%), 31 females.

Although the males can be distinguished from the preceding species by the position of the stigma and by examining the genitalia, the only sure way to separate the females is by examining their genitalia.

SIZE : The males and females range in size from 14 mm. to 16 mm., averaging only about 1 mm. smaller than *P. thrax thrax* from Delhi.

DISTRIBUTION : Evans (1949) records specimens in the British Museum (N.H.) from virtually throughout India, including Punjab, Sind, and U.P. It has also been recorded from Lucknow (de Rhé-Philipe 1902), Jodhpur (MacPherson 1927), Lahore (de Rhé-Philipe 1917), and Sind (Menesse 1950). There is a male in the MSU collection from Aligarh, U.P. (17 Nov. 1962, RLD).

PAPILIONIDAE

***Polydorus aristolochiae aristolochiae* (Fabricius)**

Although the specific name of this species was upheld by Opinion 265 in 1954 (rather than supplanting it with *ascanius* or *diphilus*, see Talbot 1947, p. 491), the generic name is still being debated. Munroe (1961) has placed this species in the genus *Pachlioptera* Reakirt, but Kent H. Wilson (pers. comm.) believes that it will come to rest in *Parides* Hübner. For the time being the arrangement of Talbot (1939) will be followed.

Only four Delhi specimens have been examined : a male collected by JPD in the Nursery on 27 Sept. 1961 (46 mm.), two males collected in Delhi in Oct. 1962 by Leela R. Menon (both 48 mm.), and a male collected in Delhi in Nov. 1962 by Miss Nirmala (48 mm.). The fact that three specimens were collected on the north side of Delhi in a two-month period may indicate that the species is more common there.

Longstaff (1912) reported that he saw 'many' in Delhi, 7-12 Nov. 1903.

DISTRIBUTION: The Common Rose is widespread throughout India (Talbot 1939; Wynter-Blyth 1957), and has been recorded as far west as West Pakistan (Menesse 1950).

Papilio polytes romulus Cramer

This swallowtail, the subject of a great deal of study because of the mimetic colour patterns of the females, is not very common in Delhi. It has been collected on the Ridge only once (Feb. IV), and at scattered times in the Nursery: March I and IV; May I; and July II to Nov. I. 31 specimens: 13 males (42%), 18 females, of which two (11%) are form 'romulus' Cramer, a mimic of *Polydorus hector* (Linnaeus), which has not been recorded in Delhi; seven (39%) are form 'cyrus' Fabricius, which has the same facies as the male; and nine (50%) are form 'stichius' (Hübner), whose model is *Polydorus aristolochiae*; a species which appears to be less common in Delhi than its mimic.

The 'cyrus' form of the female has been observed ovipositing on lime bushes (*Citrus*) on two occasions: on 21 Aug. 1962; and on 6 Sept. 1961, when one laid nine eggs (one egg to a leaf) on a single lime bush before the specimen was collected.

The larvae of both *P. polytes* and *P. demoleus* may be found on the *Citrus* bushes in the Nursery, but only one male was reared: the larvae pupated on 5 Sept. 1961, and the adult emerged 14 Sept. 1961.

On 27 July 1961 an egg of either *P. polytes* or *P. demoleus* was collected from a lime bush in the Nursery (the egg was about 3 mm. from the edge, on the underside of the leaf). On the evening of 28 July 1961 a hymenopterous parasite was observed emerging from the egg, and by the next day three parasites had emerged. They have been identified as *Telenomus (Aholcus) talaus* Nixon (Scelionidae) by C.F.W. Muesebeck of the U.S. National Museum, where all three specimens are deposited. The type series of this parasite was described from the eggs of *Graphium agamemnon* (Linnaeus) in Malaya.

SIZE: ♂♂ 38 mm. (7 March 1964, RLD) to 50 mm. (several); ♀ form 'stichius' 46 mm. (15 July 1961, JPD) to 53 mm. (28 Aug. 1961, JPD); ♀ form 'cyrus' 44 mm. (26 Aug. 1961, JPD) to 52 mm. (22 July 1961, JPD); ♀ form 'romulus' 51 mm. (2 May 1963, RLD) and 52 mm. (13 Aug. 1962, JPD).

VARIATION: *Papilio polytes* is one of the classic examples of polychromic mimicry. Goldschmidt (1945) proposes hypothetical genotypes for all forms of this species, and includes a good bibliography on the subject.

Annandale & Dover (1921) have summarized the relative abundance of the three female forms in India. In general, the most common is 'stichius,' followed by 'romulus' and 'cyrus.' The 'cyrus' form is considered to be absent or rare in many localities. In north India, including Delhi, the 'romulus' form becomes less common, where its model, *Polydorus hector*, apparently does not occur.

Sevastopulo (1947, 1956) reared 175 *P. polytes* from eggs in Calcutta. Of the 95 females he obtained, 68% were 'stichius,' 19% were 'cyrus' and 13% were 'romulus.' Sanders (1955), however, found that the 'cyrus' form was only very rarely collected in Calcutta.

The most important point concerning the Delhi female forms is that the male-like 'cyrus' form is relatively common, perhaps because there is little natural selection for the two mimetic forms when the models are uncommon (*P. aristolochiae*) or absent (*P. hector*) in Delhi.

DISTRIBUTION: The Common Mormon is found throughout India (Talbot 1939; Wynter-Blyth 1957). In Lucknow the 'stichius' female is most common, 'romulus' is rare, and 'cyrus' has not been found (de Rhé-Philipe 1902). In Jodhpur the 'cyrus' female has not been recorded (MacPherson 1927). It is interesting to note that MacPherson (1927) found *Polydorus hector*, the model for the 'romulus' form of *P. polytes*, in Jodhpur in 1924, which is apparently the northernmost record for the species.

***Papilio demoleus demoleus* Linnaeus**

The Lime Butterfly is the most common Delhi swallowtail, and is usually found in the Nursery where its foodplant, *Citrus*, is cultivated, although specimens are occasionally encountered on the Ridge. It has been recorded in March II (Ridge) and May IV, from July I to Sept. IV, and Nov. I. The poor representation of some months may be because the species is so common and easily recognized that it is not collected. 48 specimens: 28 males (58%), 20 females. Females have only been collected from July I to Sept. IV.

A copulating pair was collected on 13 July 1961 (JPD), and a female was observed ovipositing on young basal leaves of *Citrus* on 15 July 1961. Several larvae, which are very similar to the larvae of *P. polytes*, were collected from *Citrus*, and four were reared through to adults. The pupation dates were 1 Aug., 2 Sept., 2 Sept., and 3 Sept. 1961. The emergence dates were 16 Aug. (?), 13 Sept., 14 Sept., and 14 Sept. 1961, respectively.

See the comments under *P. polytes* for notes on egg parasites of *P. demoleus* or *P. polytes*.

SIZE: ♂♂ 33 mm. (4 Aug. 1962, JPD) to 47 mm. (15 July 1961, JPD). ♀♀ vary only slightly, from 44 to 50 mm. Assuming that 'expanse' is

twice the length of one forewing, the small male cited here is about the same size as the smallest *P. demoleus* (? sex) cited by Crawford (1930).

DISTRIBUTION: This species is common throughout India (Talbot 1939 : Wynter-Blyth 1957).

Graphium nomius nomius (Esper)

The only known Delhi specimen of the Spot Swordtail was collected at midday in the Nursery on 20 July 1962 as it fed on a white-flowered *Lantana*. The specimen, a female, is virtually perfect (the left tail is missing), and the forewing is 40 mm. long.

DISTRIBUTION: The distribution given by Talbot (1939), 'Ceylon, Southern India to the Sikkim lowlands,' leaves much to be desired. According to Wynter-Blyth (1957) this species occurs in the Himalaya from Simla east, and in peninsular India north to Madhya Pradesh and southern Bihar, west to Saurashtra and Lucknow. At first de Rhé-Philipe (1902) considered it rare in Lucknow, but later he (1905) reported that it was regular in July and August. It was observed at Mahuva, on the west coast of the Gulf of Cambay, Gujarat, by Mosse (1929), and has been taken on Mount Abu (MacPherson 1927). Delhi appears to be the westernmost record of this species in the Indo-Gangetic plain north of Gujarat.

PIERIDAE

Leptosia nina nina (Fabricius)

The Psyche is rare in Delhi : it has been found only in moist, shaded portions of the Nursery, where it may be flushed by beating the grass. Its habitat is essentially the same as that of *Euploea core*. The three specimens were collected on 26 Aug. (♀, 17 mm.), 25 Sept. (♀, 14 mm.), and 4 Nov. 1961 (♂, 18 mm.).

Longstaff (1912) found this species in Delhi, 7-12 Nov. 1903.

DISTRIBUTION: This fragile butterfly occurs more or less throughout India, but the western limits of its range are not well defined (Wynter-Blyth 1957 ; Talbot 1939). It is very local in Lucknow (de Rhé-Philipe 1905), but it has not been reported south-west or west of Delhi. Despite Wynter-Blyth's (1957) statement that it occurs in Sind, Menesse (1950) and Swinhoe (1887) have failed to record it from that region. Delhi, therefore, appears to be the westernmost record of this species in India.

***Delias eucharis* (Drury)**

This species was first observed feeding on *Lantana* in the Nursery on 5 Nov. 1961, and another specimen was observed flying over the Nursery the next day, but the first specimen was not collected until 23 Nov. 1961, when a worn female was caught on *Lantana* in the Nursery. The only other Delhi specimen examined was another worn female collected by RLD in the Nursery on 21 March 1965.

SIZE: The forewing of both specimens is 38 mm. long.

DISTRIBUTION: The Common Jezebel occurs from the lower slopes of the Himalaya south to Ceylon (Talbot 1939), although it is less common in the north-western part of its range. It is seasonally common in Lucknow (de Rhé-Philipe 1902) and Fatehgarh (Peile 1911), but is apparently rare in Jodhpur (MacPherson 1927), Lahore (de Rhé-Philipe 1917), and Kanpur, U.P. (Sevastopulo 1948). Delhi appears to be near the western periphery of the range of this species, since there are no records from West Pakistan.

***Cepora nerissa phryne* (Fabricius)**

The Common Gull occurs from July II to May I in all habitats, although it is more frequently collected in the Nursery. It is uncommon from December through May, a period in which the females are more frequent than males. Longstaff (1912) found only males of this species in Delhi, 7-12 Nov. 1903. 126 specimens: 65 males (52%), 61 females.

SIZE: ♂♂ 20 mm. (25 Dec. 1962, RCF) to 29 mm. (31 July 1962, JPD). ♀♀ 18 mm. (26 Feb. 1963, RCF) to 29 mm. (17 Aug. 1962, JPD).

VARIATION: Males and females from mid-April to mid-November are larger and darker, with the veins UNH prominently blackened, while dry-season specimens are smaller, with the UNH ground colour a paler yellow, with the veins blackened faintly or not at all.

DISTRIBUTION: Throughout peninsular India (Talbot 1939), at least as far west as Jodhpur (MacPherson 1927) and Lahore (de Rhé-Philipe 1917). It has not been recorded from Sind (Menesse 1950).

***Anapheis aurota aurota* (Fabricius)**

The Pioneer is one of the most common Delhi butterflies, occurring in all habitats throughout the year: abundant from March to May, then becoming less frequent until November, when it becomes common again. Uncommon in January. 362 specimens: 205 males (57%), 157 females.

Longstaff (1912) says this species was 'abundant at flowers' 7-12 Nov. 1903, and saw 'countless crowds' at Mahrauli (8 miles SSW. of New Delhi).

The sex ratio of field-collected specimens varies markedly: 46% males April II (20 specimens); 53% males for the month of March (166 specimens); 73% males in a series of 41 specimens collected at Tughlakabad, 10 Nov. 1962 (RCF); and 84% males May I (25 specimens).

Four copulating pairs have been collected: 24 March 1963 (2 pairs, RLD); 10 April 1962 (JPD); and 13 April 1962 (JPD, male very worn). On 2 May 1962 a cluster of four pupae and nine pupal cases was found on a thorny twig on the Ridge. Adults emerged from three of the pupae the next day (the fourth was preserved before emergence). Nurse (1899) has also observed over a dozen pupae on a single twig, in Kutch. Two larvae were also collected on 2 May. One was lost, but the second pupated on 4 May and emerged (σ) on 10 May 1962.

Adults were observed on Neem flowers (*Azadirachta indica*) on 2 May 1962. This species has also been observed attracted to light in Delhi (Donahue, MS. in preparation).

SIZE: $\sigma\sigma$ 18 mm. (2 May 1962, JPD; 16 June 1964, RCF) to 27 mm. (many specimens throughout the year). ♀♀ 18 mm. (14 Nov. 1963, RLD) to 29 mm. (11 March 1963, RLD; 10 Nov. 1962, RCF).

VARIATION: The seasonal forms are difficult to characterize, but specimens collected from May to August generally have less black suffusion on the veins and a paler ground colour UNH than dry season specimens. Three males collected in March (RCF) and May (JPD) have the spot at the end of the cell UPF detached from the costa, as opposed to most specimens, which have the spot connected to the costa with a dark band.

DISTRIBUTION: The Pioneer is common in India, extending west to Palestine and Africa (Talbot 1939).

Appias libythea libythea (Fabricius)

The Striped Albatross is the least common of the large Delhi 'whites'. It occurs on both the Ridge and in the Nursery, August IV (Nursery only), Nov. I to Dec. III, and Feb. IV (Ridge, one male). The females have only been collected in Aug. IV and again in December. This butterfly may be more frequent in Delhi, but it is possibly overlooked because of its general resemblance to several other pierids (*Cepora nerissa*, *Catopsilia* spp., *Anapheis aurota*). A copulating pair was collected on 28 Aug. 1961 (JPD). 20 specimens: 15 males (75%), 5 females.

SIZE: $\sigma\sigma$ 22 mm. (1 Dec. 1962, RLD) to 29 mm. (29 Aug. 1961, JPD). ♀♀ 21 mm. (25 Dec. 1962, RCF) to 24 mm. (28 Aug. 1961, JPD).

VARIATION: The August specimens are largest. The four August males have darker markings on the apex and margin UPF than dry season specimens; the only August female is darker on the upperside than the December females, e.g. UPH with large marginal spots, a discal band, and streaks connecting the spots with the band.

DISTRIBUTION: Peninsular India to the Punjab (Talbot 1939). It is rare in Lucknow (de Rhé-Philipe 1902, 1905, who identified it as *A. paulina*, which does not occur in north India) and on Mount Abu (MacPherson 1927). It has also been recorded from Lahore (de Rhé-Philipe 1917), and southward in peninsular India. There is also a female in the MSU collection from Siliserh, Rajasthan, 19 Nov. 1963 (RLD). This species is apparently uncommon but widely distributed in India.

Pieris canidia indica Evans

The Indian Cabbage White is one of the butterflies whose occurrence in Delhi came as a surprise. Only five specimens have been collected: a male from the Nursery on 28 March 1963 (RLD), 26 mm.; and four specimens from the Ridge—a female on 21 Feb. 1963 (RCF), 25 mm.; two females on 12 April 1963 (RCF), 22 and 23 mm.; and a male on 13 April 1963 (RCF) 23 mm. There is also a single specimen in the I.A.R.I. collection, obtained in Delhi by M. G. Ramdas Menon, 6 March 1958.

DISTRIBUTION: This subspecies is normally confined to the Himalaya, where it is very common (Wynter-Blyth 1957; Talbot 1939), but it has been reported south of the hills several times. Sanders (1930) found it 15 miles NE. of Amritsar, Punjab, on 23 Feb., and again in late March, when it was present in 'considerable quantities.' Sevas-topulo (1948) also reports that it is 'common at Amritsar before the weather gets hot,' and de Rhé-Philipe (1902) captured a single faded female in Lucknow in April. Although de Rhé-Philipe (1917) failed to record it from Lahore, he did observe *P. brassicae* there in Nov., Jan., and Feb. *Pieris brassicae* is also reportedly common in Fatehgarh in the early spring (Peile 1911).

Delhi is apparently the south-western most record of this subspecies.

Ixias marianne marianne (Cramer)

The White Orange Tip, like many other Delhi butterflies, is rare in the cold months of January and February, and again in the hot dry months from April to early July. It is common during the monsoon, but the population tapers off again in December. Although more frequently collected in the Nursery, it also occurs on the Ridge where

it is occasionally numerous. It has been recorded in Delhi from July I to Jan. I, and Feb. II to May II. 210 specimens: 118 males (56%), 92 females. The sex ratio of field-collected specimens appears to remain fairly constant.

Longstaff (1912) collected this species at Mahrauli (10 Nov. 1903) and in Delhi (7-12 Nov. 1903).

SIZE: ♂♂ 19 mm. (23 March 1963, RCF; 21 Feb. 1963, RCF) to 28 mm. (28 Aug. 1961, JPD). ♀♀ 21 mm. (several August specimens) to 27 mm. (29 Aug. 1961, JPD).

VARIATION: Wet season specimens of this variable species tend to be more heavily marked. Three of the females examined had none of the usual black spots in the orange subapical band UPF (13 April 1963, RCF; 25 Sept. 1961, JPD; and 24 Nov. 1962, RCF). In the dry season form of the female, which occurs from early November through May, the dark band bordering the proximal edge of the orange subapical band UPF is absent.

DISTRIBUTION: This handsome species is endemic to India, and occurs from the Punjab, U.P., and Nepal south to Ceylon (Talbot 1939; Gabriel 1943). Wynter-Blyth (1957) adds Saurashtra and Bengal to this range. It is common in Lucknow (de Rhé-Philipe 1902); apparently absent from Jodhpur, although it is common on Mount Abu (MacPherson 1927); and very rare in Lahore (de Rhé-Philipe 1917). It appears to be absent from Kutch, but it is common in adjacent Kathiawar (Mosse 1929). The MSU collection contains specimens from 15 miles south of Saharanpur, U.P. (8-9 May 1961); Aligarh, U.P. (17 Nov. 1962, RLD); and Amber, Rajasthan (7 miles north of Jaipur, 15 Nov. 1963, RLD). Delhi may be near the western periphery of the range of this species, since the specimen from Amber is the only record from northern or central Rajasthan known to the author.

Ixias pyrene sesia (Fabricius)

There is still some doubt surrounding the subspecies to which the Delhi population should belong. According to Talbot (1939), Delhi specimens would belong to *I. p. kausala* Moore, since the female is often white. But Gabriel, who revised the genus in 1943, ascribes white female forms to both *I. p. sesia* and *I. p. kausala*, and only gives Himalayan localities for the distribution of the latter. A careful examination of the descriptions in Talbot (1939) and Gabriel (1943), an examination of the figures in Swinhoe (1905-1910), and a comparison of Delhi specimens with *I. p. sesia* from south India led to the conclusion that the Delhi population is probably referable to *Ixias pyrene sesia* (Fabricius).

The Yellow Orange Tip is less common in Delhi than *I. marianne*, and occurs from Aug. III to Sept. IV, and again from Nov. I to May II. There are no records from June, July, or October, although this may be due to incomplete sampling. This species is common in March, and apparently common from the wet season through December. 86 specimens: 62 males (72%), 24 females.

Longstaff (1912) found the Yellow Orange Tip in Mahrauli (10 Nov. 1903) and in Delhi (7-12 Nov. 1903), when he saw only two specimens.

SIZE: ♂♂ 19 mm. (29 March 1964, RCF) to 27 mm. (3 Sept. 1962, RLD). ♀♀ 19 mm. (26 Feb. 1963, RCF) to 27 mm. (17 Aug. 1962, JPD).

VARIATION: Both seasonal and sexual dichromism are conspicuous in this species. The wet-season form, characterized by its larger size and wide marginal band UPH, occurs in August and September. Wet-season females are further characterized by the wide discal band UPF, which is more or less uniform in width to the tornus. Transitional forms with a macular margin UPH occur in early November, but the dry-season form appears in late November and flies until May. Most dry-season specimens have no trace of the marginal band UPH, and the females have only a narrow line connecting the bar at the end of the cell UPF with the tornus.

Two colour phases of the female occur: ground colour white or greenish white, with a slightly darker subapical band UPF; and ground colour pale yellow or greenish yellow, with the subapical band UPF of the same colour or pale orange. Both forms are about equal in frequency, fly together, and are apparently not associated with a particular season as are the female forms of *Colotis fausta*.

DISTRIBUTION: The Yellow Orange Tip appears to be uncommon in the arid plains of north-western India. The male is common in Lucknow, but the female has not been taken there (de Rhé-Philippe 1902); it is absent from Jodhpur but common on Mount Abu (MacPherson 1927); and apparently rare in Fatehgarh (Peile 1911). Menesse (1950) never observed this species in Sind, so it would appear that Delhi is near the western edge of the range at this latitude.

Colotis calais amata (Fabricius)

This is a small version of *C. fausta* but, unlike that species, it is found almost exclusively in the Nursery—there are only two records, Feb. IV and March II, from the Ridge. It occurs from July III to May IV (no June records), 175 specimens: 113 males (65%), 60 females, 2 unsexed. Infrequent from January to March, and in September and October (insufficient collecting?).

Longstaff (1912) found this butterfly 'abundant alike in the Kudsia gardens and close to the hotel . . .', in Delhi, 7-12 Nov. 1903. He also noted that one specimen was 'very small'.

SIZE: ♂♂ 13.5 mm. (22 Nov. 1962, RCF) to 20 mm. (26 Aug. 1962, RLD). ♀♀ 15 mm. (29 May 1962, JPD) to 21 mm. (29 Aug. 1961, JPD).

VARIATION: Specimens collected from July III through March are generally larger and darker than specimens collected in April and May. This is an unusual distribution of seasonal forms, since the forms do not correlate well with precipitation patterns. But April and May are two of the warmest months of the year, so temperature or insolation may be the dominant environmental factors affecting the appearance of the forms. There are no records from June, which is another of the warmest months.

DISTRIBUTION: This subspecies of the small Salmon Arab occurs from Bombay north to Sind, Baluchistan, and U.P., west to Iran and Syria (Talbot 1939). It has not been reported from Lucknow (de Rhé-Philipe 1902), but it is fairly common in Jodhpur (MacPherson 1927), common in Lahore (de Rhé-Philipe 1917), and common in Sind (Fraser 1911; Menesse 1950). Two additional specimens are in the MSU collection from Agra, U.P. (21 Nov. 1957). Delhi appears to be near the north-eastern edge of the range of this species.

Colotis vestalis vestalis (Butler)

The White Arab, like its relative *C. calais*, is found exclusively in the Nursery, where it is very common during the monsoon, although it has been collected there every month of the year. 167 specimens: 102 males (61%), 65 females.

SIZE: ♂♂ 15 mm. (29 May 1962, JPD) to 20 mm. (several specimens collected during the monsoon). ♀♀ 14 mm. (30 April 1963, RLD) to 21 mm. (two specimens, 31 July 1962, JPD).

VARIATION: The seasonal forms are not well differentiated, except that specimens flying during the monsoon are brighter yellow on the underside.

DISTRIBUTION: This species occurs from the Persian Gulf east to Sind, Baluchistan, and the U.P. (Talbot 1939). It is common in Sind throughout the year (Fraser 1911; Menesse 1950); 'exceedingly abundant' during all months except May and June in Lahore (de Rhé-Philipe 1917); common in Lyallpur, W. Pakistan (70 miles west of Lahore: Sevastopulo 1948); and common during the fall and winter months in Jodhpur (MacPherson 1927). It has not been recorded from Lucknow (de Rhé-Philipe 1902). The author obtained several specimens in Agra, U.P. (21 Nov. 1957).

Delhi is apparently near the north-eastern edge of the range of this species.

***Colotis fausta faustina* (C. & R. Felder)**

The Large Salmon Arab, the most striking of the Delhi *Colotis*, was not found until the first trip to the Ridge, to which it is restricted and where it is abundant virtually throughout the year, Nov. I to Dec. IV, and Feb. III to Sept. IV. Cold weather may account for its absence in January, but it should occur in October. 214 specimens : 146 males (68%), 68 females.

The sex ratio varies somewhat, although probably not significantly. On 14 Aug. 1962, 27 specimens were collected, of which 22 (81%) were males. On 20 Aug. 1962, 18 specimens were obtained, of which 12 (68%) were males. Only the white form of the female occurs in August and, since they are not frequent, they were collected in preference to the males—hence the actual percentage of males flying was probably greater than indicated by the figures above. On 18 Nov. 1962, when the salmon-coloured females could not be distinguished from the males, 27 specimens were collected (RCF), of which 19 (70%) were males.

VARIATION: The females occur in two forms: a form with a white or salmon-white ground colour on the upper- and undersides, which flies from Aug. II to Nov. I (no October records); and a salmon-coloured form, indistinguishable from males, which flies from Nov. I to Dec. IV and from Feb. IV to July I. Previous authors have failed to observe that these two colour phases are seasonal—the white or salmon-white form flying in the wet season, the salmon form flying in the dry season. Both forms fly together in the first week of November, and may also be found to occur together in October.

The dry-season form of both sexes (Nov. I to July I) is also characterized by being smaller and having the black markings on the upperside reduced: the black apical markings UPF are less extensive, and the black margin UPH is reduced to separate spots, a very narrow line, or is entirely absent.

One symmetrically aberrant male (15 Feb. 1964, RCF) has a rounded apex on both forewings, quite unlike the apex of normal specimens. The black apical markings UPF are consequently more reduced than usual for the DSF.

PREDATOR RECORD: On 20 August 1962 a specimen was observed being eaten by a praying mantis, identified as a nymph of *Gongylus gongyloides* (Linnaeus) (Orthoptera: Mantidae) by Dr. Irving J. Cantrall of the University of Michigan.

DISTRIBUTION: This subspecies is reported as 'not rare' from the Punjab to Sind and Karwar, Mysore. The nominate subspecies occurs

as far west as South Arabia, Turkey, and Egypt (Talbot 1939). Published records of this species are sparse, perhaps due to its very local occurrence. The only records near Delhi are a few sight records in Jodhpur (MacPherson 1927), a single specimen collected in Lahore in October (de Rhé-Philipe 1917), a female in the MSU collection from Pali, Rajasthan (4 Oct. 1961), and a male from Siliserh, Rajasthan (19 Nov. 1963, RLD). This species is more common in Kutch (Nurse 1899) and Kathiawar (Mosse 1929), but Aldrich (1946) records it as 'not rare' in Kaira District. It is reportedly rare in Sind (Fraser 1911; Menesse 1950).

Delhi is apparently the north-easternmost record of this species in India.

Colotis etrida etrida (Boisduval)

The Little Orange Tip is the only *Colotis* which is common in all Delhi habitats. It occurs from Nov. I to Sept. I, but appears to be uncommon (or poorly collected) in January, June, September, and October. 322 specimens: 192 males (60%), 130 females.

Longstaff (1912) found it 'in abundance, flying close to the ground' in Mahrauli, 10 Nov. 1903.

SIZE: ♂♂ 13 mm. (3 March 1963, RCF) to 19.5 mm. (9 Aug. 1962, JPD). ♀♀ 11 mm. (9 May 1962, JPD) to 20 mm. (17 Aug. 1962, JPD).

VARIATION: Wet-season specimens are usually larger and darker on the upperside than dry-season specimens. The wet-season form, which flies from April through September, is almost immaculate UNH, but males have marginal black spots UPH. The dry-season form, which occurs from November through March, has a considerable amount of black dusting UNH, while the males have almost no trace of the marginal spots UPH.

Two extreme wet-season females (9 Aug. 1962, JPD) have the apical black UPF so extensive that only a trace of the orange band shows. The underside of these specimens is more yellow than usual.

DISTRIBUTION: This species occurs from peninsular India to the Himalaya (Talbot 1939). It is rare in Lucknow (de Rhé-Philipe 1902); fairly common in Jodhpur (MacPherson 1927); common in the Hardoi District, 190 miles SE. of Delhi (de Rhé-Philipe 1902); common in Lahore (de Rhé-Philipe 1917); and common in Sind (Fraser 1911; Menesse 1950). Additional specimens from Siliserh, Rajasthan (19 Nov. 1963, RLD) and Agra, U.P. (21 Nov. 1957) are in the MSU collection.

Genus *Catopsilia* Hübner

There is a strong belief by many workers that *C. crocale* and *C. pomona* are conspecific, and that *C. florella* and *C. pyranthe* are also

conspecific (see Sevastopulo 1950; and Talbot 1939 and 1947, p. 493, for a summary of current thinking). The four 'species' are treated as entities in this paper merely because they can be easily separated. No endorsement, expressed or implied, is intended concerning the conspecific or distinct status of these four 'species'.

Catopsilia crocale crocale (Cramer)

The Common Emigrant has been collected only in the Nursery, from July II to Nov. I (no October records). 38 specimens: 23 males (61%), 15 females, of which 10 (67%) are form '*jugurtha*' (Cramer), 3 (20%) are form '*crocale*' (Cramer), and 2 (13%) are form '*jugurthina*' (Godart). The '*crocale*' and '*jugurthina*' forms have only been collected in July. The male forms '*alcmeone*' (Cramer) and '*flavescens*' Fröhstorfer are considered together, since there is some overlap in the colour pattern.

SIZE: ♂♂ 29 mm. (15 July 1961, JPD) to 37 mm. (13 July 1961, JPD). ♀♀ 24 mm. ('*jugurthina*,' 15 July 1961, JPD) to 39 mm. '*crocale*,' 14 July 1961, JPD).

DISTRIBUTION: 'Very common' throughout India (Wynter-Blyth 1957; Talbot 1939). It has been recorded as common in Lucknow (de Rhé-Philipe 1902), Lahore (de Rhé-Philipe 1917), Jodhpur (MacPherson 1927), and Sind (Menesse 1950).

Catopsilia pomona (Fabricius)

The Lemon Emigrant is apparently the rarest of the four 'species' of *Catopsilia* in Delhi. Less than 4% of the *Catopsilia* specimens are referable to this 'species'. The rapid flight of *Catopsilia* makes them difficult to collect, so this 'species' may be more common than the records indicate. All ten specimens are from the Nursery, except for a male collected on the Ridge, 23 April 1963 (RCF), 36 mm. Males were collected in the Nursery on 15 July 1961 (JPD), 37 mm.; 28 Aug. 1961 (JPD), 31 mm.; and 29 Aug. 1961 (JPD) 32 mm. The female form '*hilaria*' (Stoll) has been collected on 5 Jan. 1963 (RLD), 27 mm.; 6 Jan. 1963 (RCF), 31 mm.; and 21 July 1962 (JPD), 28 mm. The female form '*catilla*' (Cramer), usually considered 'not rare', has been collected in the Nursery on 14 July 1961 (JPD), 36 mm.; 31 Aug. 1961 (JPD), 35 mm.; and 28 Oct. 1962 (RLD), 29 mm.

DISTRIBUTION: As for *C. crocale*, except that *C. pomona* is uncommon in Jodhpur (MacPherson 1927) and Sind (Menesse 1950).